## METHODS OF RECORDING AND UTILIZING BIRD-MIGRATION DATA.

BY WITMER STONE.

The custom of recording the dates of arrival of migrant birds has been practised for a great many years in various countries, and more recently attempts have been made to encourage the keeping of such records on a uniform plan and to gather them together for the purpose of study and comparison.

In America this work was begun in 1884 under the direction of the American Ornithologists' Union, and since 1885 has been conducted by the Division of Biological Survey (formerly Ornithology and Mammalogy) of the U. S. Department of Agriculture.

All the published records with which I am familiar represent the work of one individual at each station, and until very recently there has been no attempt made to compare the records of several observers at practically the same locality.

The meagerness of the data that it is possible for one individual to gather on bird migration, compared with the magnitude of the phenomenon, must be apparent to all, and yet we are constantly attempting all sorts of estimates—as to the rapidity of flight, the relation of fluctuation of migration to temperature variation, etc.—based for the most part upon the records of individual observers.

In 1901 the Delaware Valley Ornithological Club of Philadelphia organized a corps of observers for the study of bird migration in this vicinity. This corps now numbers sixty-three, of which thirty-five are located within ten miles of the center of Philadelphia.

The study and comparison of the yearly records of these observers throws some interesting light upon the accuracy of individual records and suggests some methods by which a more correct index of the progress of migration may be obtained.

Many of the records are presented in detail each year in *Cassinia* the annual publication of the Delaware Valley Ornithological Club, and to these, as well as to the original schedules returned by the observers, I am indebted for the data discussed in the present paper.

In a paper read before the American Ornithologists' Union in New York City in November, 1905, and later published in *The Condor*, I

first called attention to the possibilities of combining a number of individual records, and later Prof. W. W. Cooke of the U. S. Department of Agriculture discussed the same question in a short paper in *The Auk* for July, 1907, p. 346. These are, I believe, the only papers dealing with this phase of the question. The well-known work of Mr. Otto Herman in Hungary, while probably based upon the most extensive series of data ever collected, does not, so far as I am aware, touch upon the comparison of individual records, at a single locality.

### Individual and Bulk Arrivals.

One of the most important points for consideration in a bird-migration record is an understanding of just what our date of arrival indicates. A migrating species is not a definite mass, like a railroad train, but a scattered host of individuals requiring weeks or even months to pass a given point and moving intermittently; consequently there may be a great many dates of arrival at that point, according to what part of the moving procession we are considering.

In the schedules furnished by the U. S. Department of Agriculture the date of "first arrival" is called for, and in addition the date when the species was next seen and when it became common. The object being to differentiate between the arrival of the main flight or "bulk" of the species and that of individual early stragglers.

With the exception of these schedules, nearly all the American migration records with which I am familiar deal only with the date of "first arrival," and in the publications that have been based upon the records of the U. S. Department of Agriculture, only one date is usually given, presumably the date of first arrival.

This would seem to indicate the unsatisfactory nature of the records of bulk arrival, as estimated by an individual observer, a fact which has impressed itself upon me after twenty-five years' experience in recording and tabulating bird migration data. It seems altogether too variable a quantity to be of practical value in making any sort of comparisons except in special instances.

Different species of birds vary in the way in which they become abundant at any point; some may come in considerable numbers on the very first day upon which they are seen or a day or so after the "first arrival," while others gradually drift in, a few each day, until all the usual haunts are populated, though it is impossible to say upon just which day they became common. In other cases large flocks may be seen passing overhead some time before any individuals establish themselves in their local summer haunts. It seems, too, that certain

species vary in their manner of arrival in different years, being concentrated one season and scattered in another.

The proper study of fluctuations in the numbers of each species at any point, such as would warrant an estimate of bulk arrival, requires, except in a few cases, far more time than the majority of observers can possibly give to the work—if indeed the task is possible for one individual—and consequently where such an estimate has been attempted the personal equation enters to such an extent as to render the results of little value.

It would seem that, with the comparatively small amount of time at the disposal of most observers, it would be better to suggest the recording of such occasional "bulk arrivals" as are so marked a feature of the migration as to become obvious, rather than to ask for a record of this sort for each species, which must from the nature of the case be in the vast majority of instances an estimate.

At the same time, however, the date of the first arrival, often an early straggler, does not in itself give us a proper record of the migration of the species, and it is here that the combination of a number of local records proves invaluable and furnishes a far more accurate résumé of the flight of the species than can possibly be obtained by any individual observer.

For instance take the arrival of the Wood Thrush in the ten-mile circle about Philadelphia in the Spring of 1906. Thirty-one observers recorded it as follows: One on April 25, two on April 28, ten on April 29, five on April 30, eight on May 1, and one each on May 2, 3, 4, 10 and 12. This record obviously warrants us in saying that for this area pioneer migrants arrived on April 25 and 28, while the bulk of the migration occurred from April 29 to May 1, after which date it was impossible, on account of the presence of the bird at almost all points, to judge how much further transient migration was in progress. The dates upon which the "first arrivals" are massed are obviously the dates upon which the "bulk" arrived. The late dates are to some extent due to failure on the part of the observer to be in the field on the day on which the species first arrived, but in part they represent actual absence of the species from these particular localities, as it is a matter of record that on several occasions a species has been seen regularly for some days at one locality before a single individual has appeared at another station nearby, in spite of careful search at the latter place.

The actual progress of the arrival of the Wood Thrush in 1906 within the Philadelphia ten-mile circle may be shown more graphically in the accompanying diagrams.

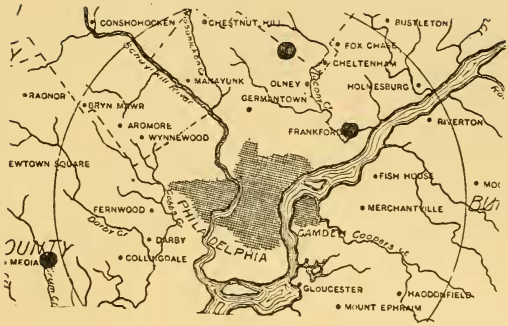



Fig. 1.

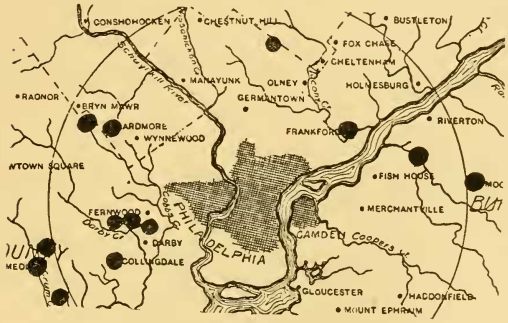



Fig. 2.

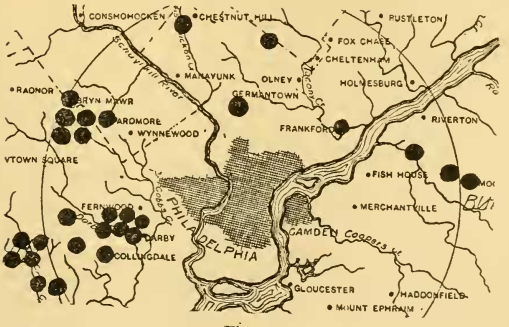



Fig. 3.

Up to April 28 (fig. 1) the species had been observed at but three stations, two of these being to the north and northeast of the city and the other to the southwest. On April 29 (fig. 2) it was present at thirteen stations, and by May 1 (fig. 3) had been reported by all but three of our observers.

Mr. Otto Herman's paper in *Proc. Fourth Internat. Ornith. Congress*, p. 163, was not received until after my diagrams had been prepared. In it he adopts practically the same plan in illustrating the migration of the Swallow in Hungary, and as his maps are based upon 5900 returns, it is needless to say they are far more convincing than mine.

## Comparison of Records.

As already stated most migration records so far obtained are the work of one individual at each locality. Now when we come to compare the time of arrival of birds at two points or their arrival at the same point on successive years, it becomes very important for us to consider the extent to which such records reflect the actual progress of migration. The discussion on determining dates of bulk movements in the vicinity of Philadelphia has already shown that while a date of "first arrival" may be perfectly accurate for the limited area covered by an observer, it would differ very materially from the earliest date of arrival for the species in a circle of five or ten miles around that observer's station.

The work of the Delaware Valley Ornithological Club for the past seven years has shown that within the Philadelphia ten-mile circle, covering an area with but little variation in altitude, we can detect no constant difference in the time of arrival of a species at any two points dependent upon their geographic position.

The earliest record is just as likely to come from the northern portion of the circle as from the southern portion. At one time the records seemed to show a slightly earlier date of arrival immediately along the Delaware river, as compared with stations a few miles back on slightly higher ground, but further data showed this difference to be purely fortuitous. Therefore we can take the records of any one station within this circle as representing the progress of migration at Philadelphia, just as well as those of any other station within the same radius, and presumably the average dates of arrival of a species for a number of years at several stations within the circle will be the same.

For certain species which are very conspicuous and which usually arrive in force on the first day of their appearance this is true, but in the majority of species it is by no means so.

Selecting three localities within the ten-mile circle, at each of which the Club has had several accurate observers for the past seven years, we have the following dates of first arrival. I = Moorestown, N. J.; II = Media and Swarthmore, Pa.; III = Haverford and Ardmore, Pa.

**Chætura pelagica** (Chimney Swift).

| | I. | II. | III. |
|---|---|---|---|
| 1901 | April 27 | April 27 | April 28 |
| 1902 | " 21 | " 22 | " 19 |
| 1903 | " 19 | " 19 | " 19 |
| 1904 | " 24 | " 24 | " 24 |
| 1905 | " 21 | " 20 | " 21 |
| 1906 | " 14 | " 12 | " 12 |
| 1907 | " 23 | " 25 | " 26 |
| Average | April 21 | April 21 | April 21 |

**Toxostoma rufum** (Brown Thrasher).

| | | | |
|---|---|---|---|
| 1901 | April 22 | April 28 | ..... |
| 1902 | " 22 | " 22 | April 24 |
| 1903 | " 5 | " 20 | " 12 |
| 1904 | " 17 | " 23 | " 15 |
| 1905 | " 22 | " 14 | " 14 |
| 1906 | " 21 | " 16 | " 17 |
| 1907 | " 28 | " 26 | " 26 |
| Average | April 19 | April 21 | April 18 |

**Piranga erythromelas** (Scarlet Tanager).

| | | | |
|---|---|---|---|
| 1901 | May 5 | May 12 | May 12 |
| 1902 | " 2 | " 1 | " 4 |
| 1903 | " 18 | " 2 | " 10 |
| 1904 | " 6 | " 6 | " 5 |
| 1905 | " 5 | " 2 | " 4 |
| 1906 | " 10 | " 1 | " 1 |
| 1907 | " 12 | " 2 | " 10 |
| Average | May 8 | May 4 | May 7 |

**Sayornis phœbe** (Phœbe).

| | | | |
|---|---|---|---|
| 1901 | ..... | Mar. 11 | Mar. 17 |
| 1902 | Mar. 30 | " 23 | " 23 |
| 1903 | " 17 | " 6 | " 15 |
| 1904 | April 3 | " 20 | " 19 |
| 1905 | Mar. 26 | " 16 | " 19 |
| 1906 | April 8 | " 12 | April 1 |
| 1907 | Mar. 17 | " 15 | Mar. 16 |
| Average | Mar. 27 | Mar. 15 | Mar. 20 |

Or, tabulating the averages obtained as above for eleven species, we have:

| | I. | II. | III. | No. of days difference. |
|---|---|---|---|---|
| *Chimney Swift* | April 21 | April 21 | April 21 | 0 |
| *Phœbe* | Mar. 27 | Mar. 15 | Mar. 20 | 12 |
| *Chipping Sparrow* | " 29 | April 1 | " 29 | 3 |
| *Scarlet Tanager* | May 8 | May 4 | May 7 | 4 |
| *Barn Swallow* | April 19 | April 19 | April 22 | 3 |
| *Black-throated Blue Warbler* | May 5 | May 2 | May 3 | 3 |
| *Ovenbird* | " 1 | April 29 | April 30 | 2 |
| *Maryland Yellow-throat* | April 25 | " 26 | May 2 | 7 |
| *Catbird* | " 28 | " 25 | April 30 | 5 |
| *Brown Thrasher* | " 19 | " 21 | " 18 | 3 |
| *Wood Thrush* | " 30 | " 27 | " 29 | 3 |

This demonstrates conclusively that the average date of arrival for a number of years, based upon the observations of a single individual, varies materially from the average date obtained by another equally accurate observer stationed but a few miles distant. The amount of difference in the case of individual observers is even greater than that shown above, as in these cases the record given for each of the three stations is the result of the combined work of several observers.

I called attention to the percentage of error in the records of individual observers in a paper read before the American Ornithologists' Union at New York in November, 1905, and during the Spring of 1907 Prof. W. W. Cooke made some experiments along the same line, and his results showed that, compared with the combined work of twenty-three other observers, in the immediate vicinity of Washington, D. C., in this single season his dates of arrival averaged one and three-tenths of a day late, and this in spite of the fact that he spent more time in the field and covered a greater variety of country. In my summary given above a single station averages one and nine-tenths of a day later than the earliest average date recorded for the species.

This information, however, does not help us in using the record of a single observer for comparative study, either as between different years or different stations, and we are forced to the conclusion that results based upon such individual records are really of but little value for comparative work, so great is the possibility of error.

For instance, quoting from Prof. W. W. Cooke's papers on the Migration of Warblers and Thrushes, as recorded in the schedules of the U. S. Department of Agriculture,[1] we have the average dates of the arrival of the following species at Germantown, Pa., a suburb of Philadelphia, and at Washington, D. C.:

[1] *Bird Lore*, 1905–1907.

| | Germantown. | Washington. | Difference. |
|---|---|---|---|
| Wood Thrush | May 1 | April 26 | 5 days. |
| Black-throated Blue Warbler | May 6 | May 2 | 4 " |
| Ovenbird | May 1[2] | April 23 | 8 " |
| Maryland Yellow Throat | April 29 | April 21 | 8 " |

These dates being the averages of a number of years, would seem to be sufficiently accurate for the purpose of estimating the time of flight of the species mentioned between Washington and Philadelphia, and by comparing them we find that it is respectively five days, four days, eight days and eight days. The Germantown records quoted from Prof. Cooke's papers are based upon schedules which I filled out for the Department of Agriculture from 1883 to 1890. I now find that my dates vary from those obtained by other observers in the neighborhood of Philadelphia from 1901 to 1907, just as the latter have been shown to vary from each other.

Had any of the other records from the vicinity of Philadelphia been used in place of the Germantown series, as would have been perfectly justifiable, a very different result would have been obtained; and there is no doubt but that the dates of several individual observers in the vicinity of Washington would show just as much diversity as is shown in our Philadelphia series, which would still further vary the results.

In a number of instances moreover the difference between the average date of arrival at Washington and Philadelphia, as given in Prof. Cooke's papers, is no greater than that between two stations well within the Philadelphia ten-mile circle.

In comparing the dates of arrival of species for several consecutive years we also find a considerable variation in the records of nearby stations which we should expect to show uniformity.

For instance, taking the eleven species given in the table on page 134, and computing the average dates of arrival for the six years 1901 to 1906 at each of the three stations, and then comparing these with the dates of arrival at each of the stations in 1907, we find that at station No. I the 1907 dates averaged three days late, while at station No. II they averaged one day late and at station No. III they averaged exactly normal, and yet each one of these stations was represented by several accurate observers, and there is nothing in their relative geographic position to warrant any difference.

### Combination of Individual Records.

After discrediting the value of individual records, one must natur-

[2] Omitted in Prof. Cooke's paper, and supplied from my own memoranda.

ally suggest some method of recording migration by which results sufficiently accurate for comparative work are to be obtained. This, I think, is to be found by securing a large number of observers in a limited area and by combining their results, as has been done by the Delaware Valley Ornithological Club in the vicinity of Philadelphia. If we had seven-year records kept by thirty-five individuals within ten miles of Washington, and a similar series within ten miles of Boston for comparison with the Philadelphia series, then I think we should be able to estimate with some degree of accuracy the progress of migration between these points.

In a composite record of this kind it is especially worthy of note that more or less fragmentary records are of great value, as an observer who only records a limited number of species may note some of them earlier than any other observer, while species which he fails to record are noted by others.

The way in which a number of indvidual records from one vicinity are to be combined in order to get the most reliable results is quite a problem.

Take, for example, the Ovenbird, *Seiurus aurocapillus*, for the years 1905, 1906 and 1907, as recorded within ten miles of Philadelphia by respectively thirty, thirty-two and thirty-four observers—the number of the observation corps varying somewhat from year to year.

We find that in 1905 it arrived at one station on April 25; at another on April 28; at eight stations on the 29th, ten on the 30th, etc., *i.e.*:

1905—April 25, 28, 29 (8), 30 (10), May 2, 3, 4, 6, 7 (2), 8, 12 (2).
1906—April 28 (2), 29 (7), 30 (4), May 1 (5), 2 (3), 3 (4), 4 (2), 5 (3), 8, 12.
1907—April 26 (2), 27, 28 (4), 29 (5), 30 (2), May 1 (5), 2 (2), 5 (4), 6, 8, 11 (4), 12, 13, 15.

If we select the earliest date for each year as the basis of our comparison, we shall say that 1905 was the earliest season and 1906 the latest. The objection to this is that it considers only the earliest stragglers, whose movements may or may not reflect those of the bulk of the species.

If we select the average of all the dates for each year we shall have for 1905 May 2, 1906 May 2, 1907 May 3, or 1905 earliest and 1907 latest. The objection in this case is that some at least of the late dates of arrival represent errors of observation—*i.e.*, failures to detect the species until it had been present for some days—while others are for stations which are not congenial haunts of the species under consideration and at which it is only occasionally seen, and by including these in our computation we obviously make the resultant date too late.

After considerating many methods it seems that the best date to select is that upon which the species had arrived at half of the stations, leaving out of consideration entirely the last quarter of the stations that recorded the species, in order to eliminate the probably erroneous or misleading dates.

Dropping the last quarter of the stations in the case of the Ovenbird, we shall have left for consideration in the three years twenty-three, twenty-four and twenty-six records respectively, *i.e.*:

1905—April 25, 28, 29 (8), 30 (10), May 2, 3, 4.
1906—April 28 (2), 29 (7), 30 (4), May 1 (5), 2 (3), 3 (3).
1907—April 26 (2), 27, 28 (4), 29 (5), 30 (2), May 1 (5), 2 (2), 5 (4), 6.

The dates by which the species had reached half these stations will then be 1905 April 30, 1906 April 30, 1907 April 30. This is perhaps a poor example as the Ovenbird is such a regular migrant. Indeed a mere glance at the records will show that the bulk of arrivals occurred in 1905 on April 29 and 30, in 1906 on the same days and in 1907 on April 28 and 29, which represents almost the same thing.[3]

In other cases, however, the massing of arrivals upon a few days is by no means so evident, and some such method as the above is absolutely necessary. For example:

**Pipilo erythrophthalmus** (Towhee).

1905—March 24, April 11 (2), 12 (2), 14 (3), 18, 19, 20, 21 (2), 22 (2), 23 (3), 24, 25 (3), 26 (2), 29, 30.
1906—March 6, April 7, 12, 15 (3), 16, 17, 19 (4), 20, 21 (5), 22 (3), 23, 24, 25 (2), 27 (2), 30 (2), May 8.
1907—March 23, 30 (2), April 3, 4, 6, 14, 16, 20, 24, 26 (5), 27 (3), 28, May 1, 4, 5, 6.

Rejecting the last quarter of the records in each year and selecting the middle one of those remaining, as before, we get:

1905 April 19, 1906 April 19, and 1907 April 20.

**Hirundo erythrogastra** (Barn Swallow).

1905—April 7, 20 (3), 21, 23 (3), 24, 25 (3), 27, 29, 30 (4), May 6, 7, 9.
1906—April 11, 12, 14, 17, 19, 21 (2), 22 (3), 25 (4), 26, 28 (2), 30, May 3, 6, 19.
1907—March 27, April 6, 20, 21, 22 (2), 24 (3), 26 (2), 27, 28 (3), 30, May 1, 2, 4, 5 (3), 8 (2), 10, 11, 12, 14.

1905 April 23, 1906 April 22, 1907 April 26.

**Toxostoma rufum** (Brown Thrasher).

1905—April 9, 13, 14 (2), 16, 18 (2), 19 (2), 21 (2), 22 (6), 23 (3), 24 (4), 25 (2), 26, 29, 30, May 3.

[3] While the migration of 1907 was very late, so far as most of the April and all the May migrants were concerned, a wave just at this time brought the Ovenbirds at their normal date.

1906—March 9, April 10, 16, 17 (2), 19 (3), 20, 21 (4), 22 (3), 24 (2), 25 (2), 26, 27, 28 (2), 30, May 1 (2), 5, 6.
1907—March 13, 17, April 20, 23, 25, 26 (6), 27 (7), 28 (2), 29 (2), 30 (2), May 1 (3), 2, 3, 4 (2), 5, 8, 11 (2).
1905 April 22, 1906 April 21, 1907 April 27.

The above plan gives us a definite date for all sorts of comparisons and one which is independent of the personal equation. The term "became common" may mean a different thing to each individual, but the date upon which a species reached half of the stations at which it was observed represents a *definite point* in the increase of its abundance, and is a matter of record and not of opinion.

As so little has been attempted in the way of combining local migration records, I find it difficult to discuss the comparative value of different methods. Some casual allusions by Prof. Cooke to the methods employed by him form indeed the only contribution to the subject with which I am familiar. He recognizes the danger of including the latest dates of arrival in computing averages and rejects them, just as I have advocated above, but in deciding how many to reject his method seems to lack definiteness and to involve the personal equation. He says (*Auk*, 1907, p. 347), "When using migration records for the calculation of average dates of arrival, I usually discard dates that are more than six days later than the probable normal date of arrival." This would seem to imply an arbitrary selection of "the probable normal" date before any averaging is done, which seems to be a dangerous method. Again, in referring to the combination of the observations of twenty-three observers at Washington, D. C., in the Spring of 1907, he says, "Many of the notes were duplicates or of *no value*, but after all these had been eliminated," etc. [Italics mine]. This is exactly the reverse of my method, instead of rejecting "duplicate" records, these seem to me to be of the utmost value as pointing to the dates upon which the greatest migration took place. It must, however, be borne in mind that Prof. Cooke in this instance is ascertaining the earliest date—not the date of bulk arrival which, as just explained, seems to me a more reliable basis for comparison of migration between two distant points, but one which, as I have also explained, is practically impossible in the absence of a large corps of observers at each point.

### Graphic Representation of Migration.

In the *Auk* for 1889 (p. 139) and 1891 (p. 194) I published some papers on the Graphic Representation of Bird Migration, based in part upon records of the Delaware Valley Ornithological Club for 1890.

The attempt was made at this time to record the actual number of individuals or the relative abundance of certain species, as noted each

day by five observers, and by plotting the daily totals a chart was obtained representing the fluctuations of the migration, which was shown to correspond to rises and falls in the curve of temperature variation for the same period. In my *Birds of Eastern Pennsylvania and New Jersey*, 1894 (p. 28), a like method was employed.

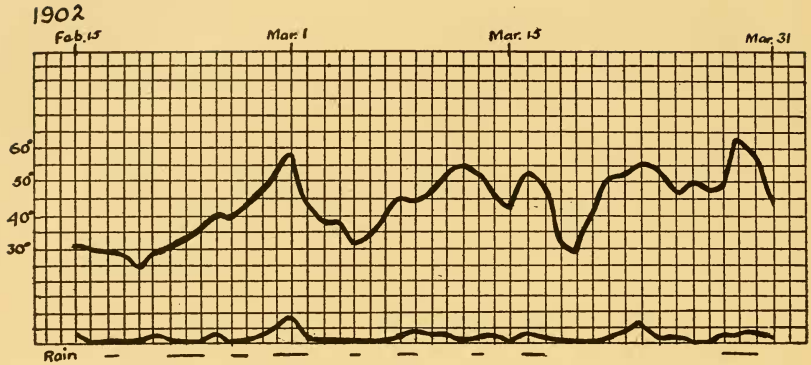
Similar and probably much more accurate results may be obtained by plotting a curve based upon the total "first arrivals" within the ten-mile circle as reported by our Philadelphia migration corps for each day of the Spring.

In the following diagrams such curves are shown for the years 1902 to 1907, accompanied by curves of temperature variation based upon the mean daily temperature at Philadelphia as recorded by the United States Weather Bureau, together with an indication of the days upon which rain or snow fell. For this meteorological data I am under obligations to Mr. T. F. Townsend, Director of the Pennsylvania Section, U. S. Weather Bureau.

In the early part of the season it will be noticed that "waves" of migration follow closely after marked rises in temperature, but later on at the height of the May migration the great "waves" or "rushes" often occur without any corresponding temperature increase.

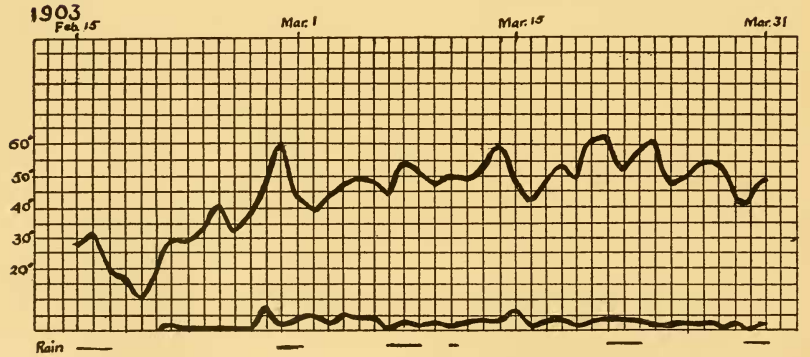
It is well known that birds do not start to migrate on a rainy night, so that it is natural to expect sudden drops in the migration curves to be correlated with spells of rainy weather, and such is often the case. Inasmuch as birds are sometimes overtaken by rainstorms after starting on a clear evening, they often arrive at a locality simultaneously with the rain, and as it is not possible to indicate in the diagrams the exact time and extent of the daily precipitation allowances must be made for some apparent discrepancies in this respect.

In the following diagrams the vertical lines represent the days from February 15 to May 18, while the horizontal lines denote five degrees difference in the temperature curve and ten units difference in the migration curve; a unit in the latter curve being a "first arrival" record at some one of the stations within ten miles of Philadelphia. Thus if the migration curve reaches ten on a certain day it means ten first arrivals, *i. e.*, one species recorded for the first time at ten stations, two species at five stations each, or ten different species each recorded at a single station as the case may be. Periods of rainy weather are indicated by the broken line immediately below the diagram, marked "rain." Each migration is divided into two sections placed opposite to each other, so that the curves run across both pages, with the comments below. In each chart the upper curve represents temperature variation, the lower migration.



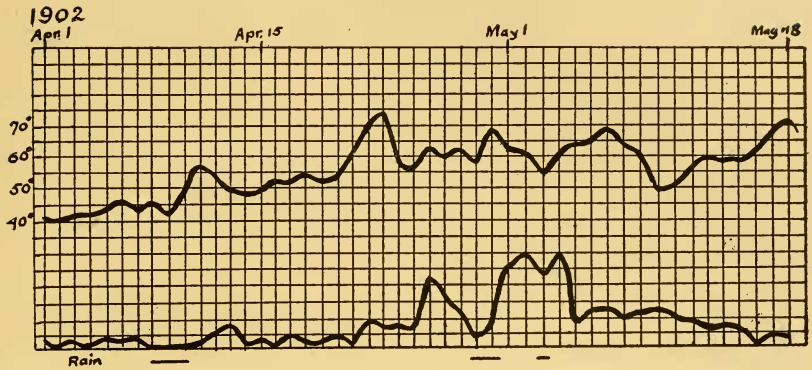

In 1902 the temperature rose steadily from February 19 to March 1, and a marked migration occurred February 27 to March 1, consisting mainly of the bulk movement of Purple Grackles and Robins.

The mean temperature during March was 46°, six degrees above the normal; the highest figures being on March 1, 12, 16, 23 and 29. Marked migratory movements occurred on March 10–11, March 23, and March

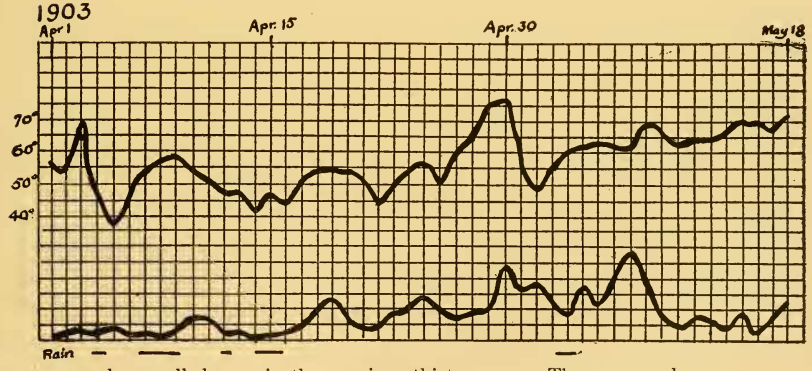



In the season of 1903 there was an almost unbroken rise in temperature from February 19 to February 28, most rapid from the 25th to the end of the month. The bulk movement of Robins and Purple Grackles took place on the 27th, accompanied this year by a considerable migration of Fox Sparrows.

The mean temperature during March was 49°—unusually high and

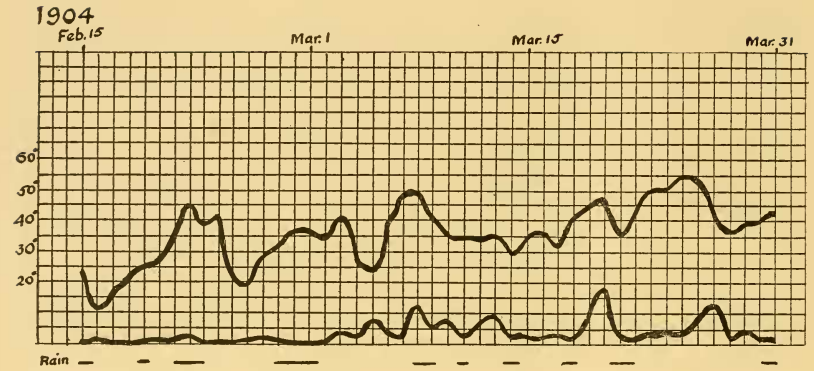



29, the Fox Sparrow being a characteristic species of the first movement, the Chipping Sparrow and Phœbe of the other two. April was but little above the normal temperature, the marked increase being on the 11th, 23d and 30th, with corresponding migration on April 12, 13, 21–22, 26, and May 1. The May movement continued until the 4th, broken on the 3d by rain.

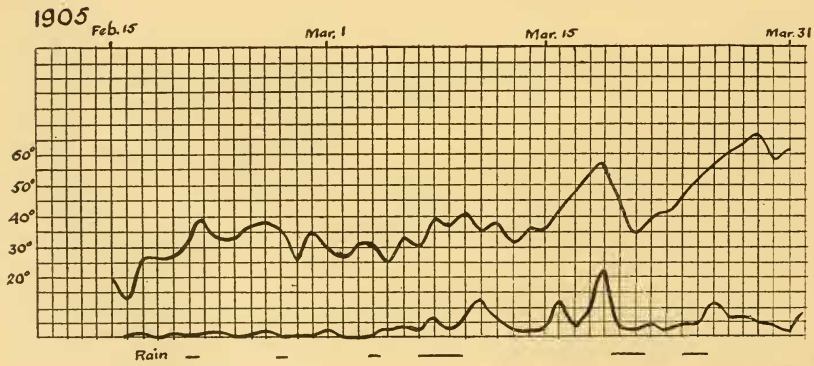



only equalled once in the previous thirty years. There was only one well-marked wave during the month, on the 15th, following the high temperature which culminated on the 14th.

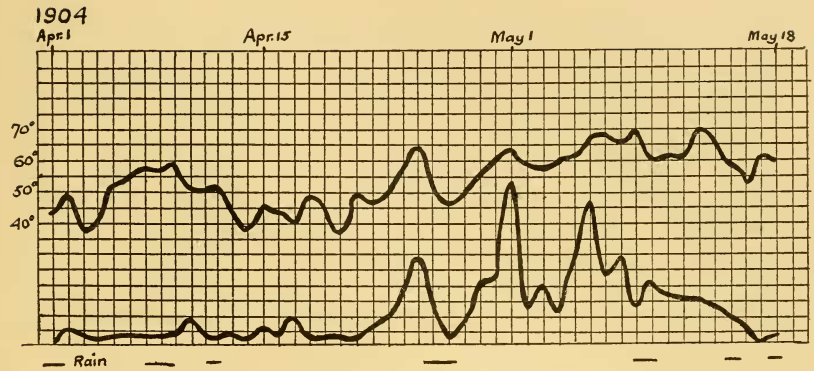
In April the coincidence of migration waves and increases in temperature will be noticed on April 9, 19, 25 and 30, with the great May movements on May 5 and 8.



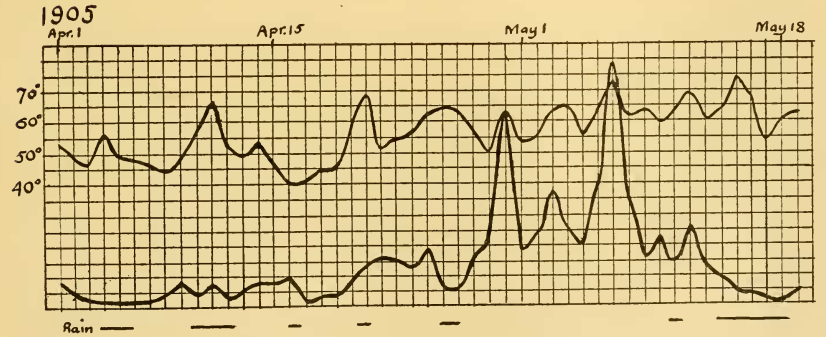

The early warm wave in 1904 occurred February 22–24, but brought only the first arrival of Robins, with no evidence of migration in other species. The rain which prevailed at the time no doubt checked any general movement. The weather during March was normal and the rises in temperature, which culminated on March 3, 7, 13, 20 and 26,




In 1905 there was no February migration. The rise in temperature on March 8 brought the first migratory movement which was checked by rain, but resumed again on March 11. High temperature March 16–19 brought two migratory movements. Rain in April at the time of sudden rises in temperature seems to have broken up the regularity of the migration or held it in check, and perhaps had something to do

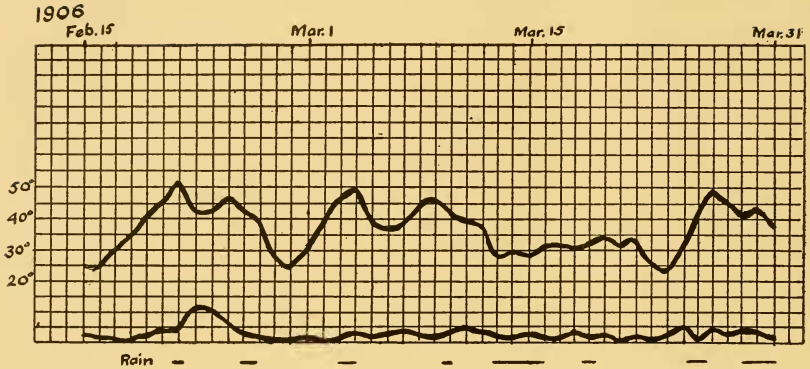



were followed by migrating movements on March 5, 8, 13, 20 and 27. In April the principal movements on the 10th and 25th corresponded to marked increases in temperature, while the great May waves occurred on the 1st and 6th.



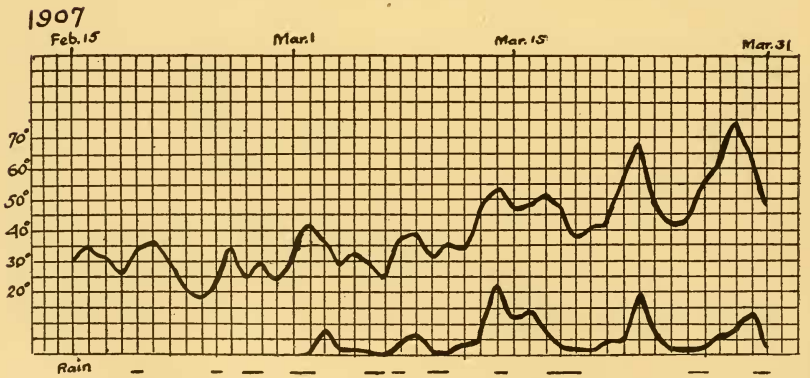

with the proportions of the wave of April 30, which followed the last spell of rainy weather and was the most extensive April movement that our records show. The May waves occurred on the 3d and 7th.

The correspondence in the migration curves for 1904 and 1905 is remarkable, the movements being about the same in number and extent and nearly the same in time of occurrence.

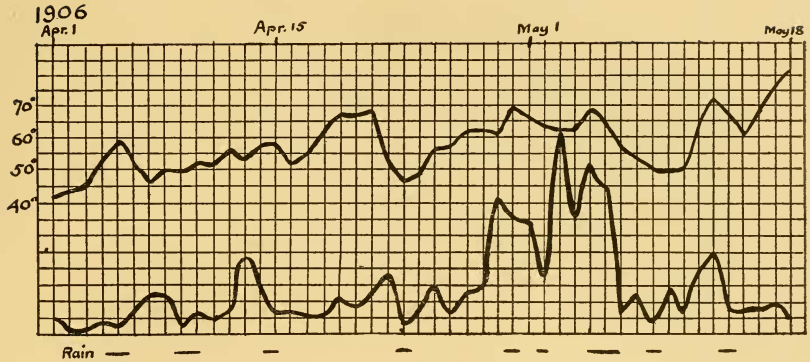



In 1906 the steady rise in temperature February 15 to 21 caused one of the most extensive February migrations of which we have record. In March, on the contrary, there was no movement of consequence, notwithstanding two considerable temperature increases culminating on the 4th and 26th.

The explanation of this is to be found in the fact that birds that usually form the early March waves had already advanced with the

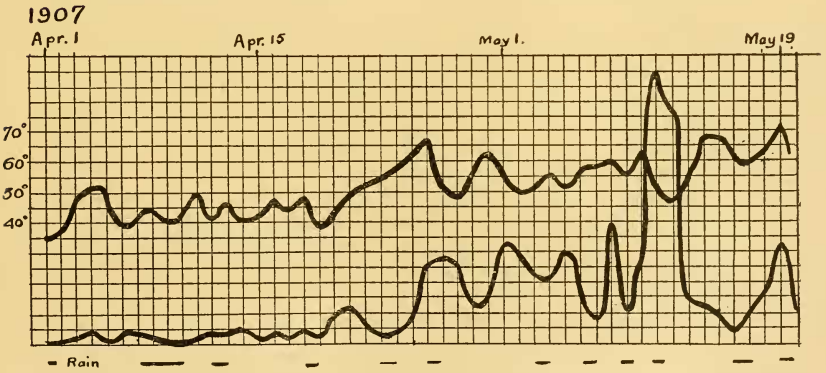



In 1907 there was no February migration whatever. March was rather warmer than usual, and the five well-marked waves correspond with unusual exactness to temperature increases. The phenomenal cold of early April brought migration to a standstill, followed by marked waves on April 21, April 26 and May 1, following increases in temperature culminating on April 26 and 30. The continued cold weather of May delayed the great migratory movements of that month until May 11–12 when the birds went through in a great throng, irrespective




great February movement, and there were no species ready to respond to the favorable conditions in March.

High temperature on April 5 was accompanied by rain and migration was not apparent until April 6 to 8 when there was an extensive movement. Another occurred on the 13th, while the high temperature of April 21 was followed by a wave on the 22d, which was resumed on April 25 after a cold rain. The greatest movements were April 29–May 1, May 3 and May 5.




of falling temperature with frost on the morning of May 12. The last May wave did not occur until the 19th.

In this season we have an example of the difficulty of characterizing an entire migration as early or late. The beginning of the movement was late, while most of the March dates of arrival were remarkably early; early April migrants were late, but the great movements at the close of the month brought conditions nearly to the normal, while the May migrants were phenomenally late.

## Waves and Their Components.

Accepting the fact that the migratory movement advances by "waves" or "rushes,"—that is to say that the bulk of the migration at each locality occurs on certain nights or series of nights,—the question naturally arises: To what extent are the several "waves" in successive years composed of the same species?

A study of the migration curves will show that there are from eleven to fourteen prominent waves during the Spring, taking into consideration only those which show ten or more arrivals[4] in February and March, fifteen to twenty in April, and thirty to one hundred in May. These seem to me to be the only movements worthy to be styled waves, although some have used the term to indicate far less marked movements, while others use it only for the most extensive migratory flights.[5]

Selecting forty-seven common species for which we have the fullest data, and noting such migratory activity[6] as is indicated by each on the wave-days for the years 1904 to 1907, we find a remarkable correspondence in the species which make up each wave. And the same "wave" may be recognized through a number of years by its component species, though its date may vary considerably. Sometimes a movement may be interrupted by unsuitable weather and be resumed again later, making two apparent waves in one year which correspond to one in other years. Or when conditions are exceptionally favorable early in the season, the species which usually compose Wave II, for instance, may push forward and form part of Wave I; and although conditions at the normal time of occurrence of Wave II may be favorable there will be no movement, simply because all the species usually migrating at that time have passed on.

It seems then that certain species migrate together, advance stragglers of some accompanying the bulk movements of others, and that each species is ready for migration at approximately the same time each year, the exact date depending upon a favorable combination of meteorological conditions.

The following tables will show which of the forty-seven selected species composed the various waves for the four years for which we

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[4] "Arrival" here has the same significance as explained on page 193.

[5] Cf. Twenty-five Years of Bird Migration at Ann Arbor, Michigan, by N. A. Wood, *Eighth Annual Report Mich. Acad. Sci.*

[6] Usually only the "first arrival" within the Philadelphia circle and the one or more marked bulk movements are considered, but sometimes when the first arrival was a very early straggler the second arrival is also noted.

have the fullest data. Many other less common species arrived on the various "wave-days," but their inclusion in the tables would only tend to confusion and would obscure the point that I wish to demonstrate. Where a species has been omitted in any year it is because it failed to arrive on one of the wave movements, or because the bulk movement was scattered and not concentrated on a "wave-day." The scarcity of such omissions, however, illustrates to what an extent the migration is concentrated on a comparatively small number of days.

"First arrival" in these tables denotes the first individual to be reported anywhere within the ten-mile circle.

WAVE I.

| | 1904. | 1905. | 1906. | 1907. |
|---|---|---|---|---|
| | *March 5.* | *March 8.* | *February 22–24.* | *March 9.* |
| *First Arrivals* | Red-winged Blackbird. | Red-winged Blackbird. | Red-winged Blackbird.<br>Fox Sparrow (2d).<br>Vesper Sparrow. | Red-winged Blackbird. |
| *Bulk Movement.* | Purple Grackle.<br>Robin. | Purple Grackle.<br>Robin. | Purple Grackle.<br>Robin.<br>Red-winged Blackbird.<br>Fox Sparrow. | Purple Grackle.<br>Robin. |

WAVE II.

| | 1904. | 1905. | 1906. | 1907. |
|---|---|---|---|---|
| | *March 8–10.* | *March 10–12.* | | *March 14–16.* |
| *First Arrivals* | Fox Sparrow (2d). | Fox Sparrow. | [Combined with Wave I this year.] | Fox Sparrow.<br>Vesper Sparrow.<br>Phœbe.<br>Myrtle Warbler.<br>Hermit Thrush. |
| *Bulk Movement* | Red-winged Blackbird.<br>Purple Grackle.<br>Robin. | Red-winged Blackbird.<br>Purple Grackle.<br>Robin. | | Red-winged Blackbird.<br>Purple Grackle.<br>Robin.<br>Fox Sparrow.<br>Phœbe. |

WAVE III.

| | 1904. | 1905. | 1906. | 1907. |
|---|---|---|---|---|
| | *March 12–13.* | *March 16.* | *March 12.* | |
| *First Arrivals* | Phœbe. | Phœbe. | Phœbe. | [Combined with Wave II this year.] |
| *Bulk Movement* | Fox Sparrow.<br>Red-winged Blackbird. | Fox Sparrow.<br>Red-winged Blackbird. | Fox Sparrow. | |

WAVE IV.

| | 1904. | 1905. | 1906. | 1907. |
|---|---|---|---|---|
| | *March 19–20.* | *March 18–19.* | *March 25.* | *March 23–24.* |
| *First Arrivals* | Vesper Sparrow.<br>Chipping Sparrow. | Vesper Sparrow.<br>Chipping Sparrow. | Chipping Sparrow. | Chipping Sparrow.<br>Towhee. |
| *Bulk Movement* | Phœbe.<br>Red-winged Blackbird. | Phœbe.<br>Red-winged Blackbird. | Red-winged Blackbird. | Phœbe.<br>Vesper Sparrow. |

WAVE V.

| | 1904. | 1905. | 1906. | 1907. |
|---|---|---|---|---|
| | *March 26–27.* | *March 26.* | *April 6–8.* | *March 29–30.* |
| *First Arrivals* | Towhee.<br>Myrtle Warbler. | Towhee. | Towhee (2d).<br>Myrtle Warbler.<br>Hermit Thrush.<br>Ruby-crown Kinglet.<br>Yellow Palm Warbler.<br>Brown Thrasher(2d).<br>House Wren. | Towhee (2d).<br>Hermit Thrush (2d).<br>Ruby-crown Kinglet.<br>Yellow Palm Warbler.<br>Barn Swallow. |
| *Bulk Movement* | Phœbe.<br>Vesper Sparrow.<br>Chipping Sparrow. | Phœbe.<br>Vesper Sparrow.<br>Chipping Sparrow. | Phœbe.<br>Vesper Sparrow.<br>Chipping Sparrow. | Phœbe.<br>Vesper Sparrow.<br>Chipping Sparrow. |

WAVE VI.

| | 1904. | 1905. | 1906. | 1907. |
|---|---|---|---|---|
| | *April 2.* | *April 1.* | [Included in Wave V.] | [Included in Wave V.] |
| *First Arrivals* | Hermit Thrush.<br>Ruby-crown Kinglet.<br>Yellow Palm Warbler. | Hermit Thrush.<br>Ruby-crown Kinglet.<br>Myrtle Warbler. | | |
| *Bulk Movement* | Chipping Sparrow. | Ruby-crown Kinglet. | | |

WAVE VII.

| | 1904. | 1905. | 1906. | 1907. |
|---|---|---|---|---|
| | *April 10 + April 17.* | *April 9–11 + April 16.* | *April 13.* | *April 20–22.* |
| *First Arrivals* | Barn Swallow.<br>Chimney Swift.<br>Brown Thrasher.<br>Black-and-White Warbler.<br>Maryland Yellow-throat. | Barn Swallow.<br>Chimney Swift.<br>Brown Thrasher.<br>Catbird.<br>Yellow Warbler.<br>Yellow Palm Warbler. | Barn Swallow.<br>Chimney Swift. | Barn Swallow.<br>Chimney Swift.<br>Black-and-White Warbler.<br>Catbird.<br>Water Thrush. |
| *Bulk Movement* | Hermit Thrush.<br>Yellow Palm Warbler.<br>Ruby-crown Kinglet.<br>Myrtle Warbler. | Hermit Thrush.<br>Yellow Palm Warbler.<br>Towhee. | Hermit Thrush.<br>Yellow Palm Warbler.<br>Ruby-crown Kinglet. | Hermit Thrush.<br>Yellow Palm Warbler.<br>Ruby-crown Kinglet.<br>Myrtle Warbler. |

### Wave VIII.

| 1904. | 1905. | 1906. | 1907. |
|---|---|---|---|
| *April 23–26.* | *April 22–25.* | *April 21–25.* | *April 26–28.* |

*First Arrivals*—Nine species have arrived on this wave in at least three of the four years, *i.e.*, Scarlet Tanager, Yellow Warbler, Black-throated Green Warbler, Ovenbird, Water Thrush, House Wren, Catbird, Wilson's Thrush and Wood Thrush. Five others arrived in two out of the four seasons, *i.e.*, Rose-breasted Grosbeak, White-eyed Vireo, Redstart, Maryland Yellow-throat and Yellow-breasted Chat.

*Bulk Movement*—The bulk of this wave comprised the same seven species in each of the four years, *i.e.*, Chimney Swift, Barn Swallow, Black-and-White Warbler, Myrtle Warbler, Maryland Yellow-throat, Brown Thrasher and House Wren. To these are to be added the Yellow Warbler in 1904 and the Ovenbird in 1907.

### Wave IX.

| 1904. | 1905. | 1906. | 1907. |
|---|---|---|---|
| *April 29–May 1 + May 3.* | *April 29–30.* | *April 29–May 1.* | *May 1–3.* |

*First Arrivals*—Six species arrived on this wave each year, *i.e.*, Baltimore Oriole, Kingbird, Red-eyed Vireo, Blue-winged Warbler, Magnolia Warbler, Parula Warbler, and in three of the four years Great Crested Flycatcher, Indigo-bird, Yellow-throated Vireo, Black-throated Blue Warbler.

*Bulk Movement*—Seven species were abundant during this wave in each of the four years, *i.e.*, Black-throated Green Warbler, Redstart, Water Thrush, Ovenbird, Catbird, Wilson's Thrush and Wood Thrush, and in three of the four the Yellow Warbler and Scarlet Tanager.

### Wave X.

| 1904. | 1905. | 1906. | 1907. |
|---|---|---|---|
| *May 5–8.* | *May 3 + 7.* | *May 5–6.* | *May 8 + 10–12.* |

*First Arrivals*—Species usually arriving on this wave Chestnut-sided Warbler, Blackburnian Warbler, Canada Warbler, Black-poll Warbler, Wood Pewee, Hummingbird, Yellow-billed Cuckoo.

*Bulk Movement*—In all four years Baltimore Oriole, Wood Pewee, Great Crested Flycatcher, Indigo-bird, Rose-breasted Grosbeak, Scarlet Tanager, Red-eyed Vireo, White-eyed Vireo, Yellow-breasted

Chat, Chestnut-sided Warbler. In three of the four years Blue-winged Warbler, Black-throated Green Warbler, Black-throated Blue Warbler, Magnolia Warbler, Black-poll Warbler, Kingbird.

WAVE XI.

| 1904. | 1905. | 1906. | 1907. |
|---|---|---|---|
| *May 10–11.* | *May 12.* | *May 12-13.* | *May 19.* |

*Bulk Movement* in all four years—Yellow-billed Cuckoo, Hummingbird, Wood Pewee, Magnolia Warbler, Blackburnian Warbler, Black-poll Warbler and Canada Warbler.

SIX YEARS RECORDS AT PHILADELPHIA.

The following tables present a summary of the arrival dates of the ninety species which are printed upon the schedules of the Delaware Valley Ornithological Club for the years 1902 to 1907, based upon the records of from twenty-five to thirty-five observers for each year, all located within ten miles of the center of Philadelphia.

Under "first arrival" is given the average date of the first observation reported by any of the observers, and also the earliest and latest first arrival for the six years under consideration. Under "bulk arrival" is given the date for each year when the species had been reported at half the stations, computed as explained on page 137, and also the average of these six dates. In some cases the data were too meager to warrant this computation, in which instances the dates are omitted and only first arrivals given. In a few species, marked by an asterisk, dates which obviously referred to winter residents have been rejected, while in the case of the Long-billed Marsh Wren, Pine Warbler and perhaps a few others the data are probably not sufficient to give accurate results, the species being rare or local.

| | First Arrival. | | | Bulk Arrival. | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Average | Extremes 1902–07 | | 1902 | 1903 | 1904 | 1905 | 1906 | 1907 | Average |
| Canada Goose, *Branta canadensis* | Mar. 4 | Feb. 20 | Mar. 14 | | | | | | | |
| Green Heron, *Butorides virescens* | Apr. 21 | Apr. 10 | Apr. 30 | Apr. 28 | May 2 | Apr. 29 | Apr. 29 | Apr. 30 | May 3 | Apr. 30 |
| Night Heron, *Nycticorax n. navius* | Mar. 29 | Mar. 22 | Apr. 10 | | | | | | | |
| Spotted Sandpiper, *Actitis macularia* | Apr. 12 | Apr. 7 | Apr. 18 | May 3 | Apr. 26 | Apr. 23 | Apr. 22 | Apr. 21 | Apr. 28 | Apr. 25 |
| Solitary Sandpiper, *Helodromas solitarius* | Apr. 22 | Apr. 14 | Apr. 30 | | | | | | | |
| Killdeer, *Oxyechus vociferus* | Mar. 2 | Feb. 25 | Mar. 5 | | | Mar. 11 | Mar. 17 | Mar. 11 | Mar. 16 | Mar. 14 |
| Dove, *Zenaidura macroura* | Mar. 7 | Feb. 23 | Mar. 15 | | | | | | | |
| Osprey, *Pandion hal. carolinensis* | Mar. 30 | Mar. 17 | Apr. 5 | | | | | | | |
| Turkey Vulture, *Cathartes aura* | Mar. 9* | Mar. 3 | Apr. 13 | | | | | | | |
| Yellow-billed Cuckoo, *Coccyzus americanus* | May 3 | Apr. 30 | May 8 | May 12 | May 8 | May 10 | May 7 | May 6 | May 11 | May 9 |
| Black-billed Cuckoo, *Coccyzus erythrophthalmus* | May 6 | May 1 | May 10 | | | May 9 | May 7 | May 13 | May 17 | May 11 |
| Kingfisher, *Ceryle alcyon* | Mar. 14 | Mar. 3 | Mar. 28 | | | Mar. 20 | Mar. 24 | Apr. 7 | Mar. 24 | Mar. 26 |
| Yellow-bellied Sapsucker, *Sphyrapicus varius* | Mar. 9 | Feb. 17 | Mar. 25 | | | Apr. 5 | Apr. 8 | Apr. 13 | Apr. 15 | Apr. 10 |
| Red-headed Woodpecker, *Melanerpes erythrocephalus* | Apr. 16 | Apr. 1 | May 8 | | | | | | | |
| Flicker, *Colaptes auratus luteus* | Feb. 17 | Feb. 8 | Mar. 3 | Feb. 24 | Mar. 10 | Mar. 13 | Mar. 18 | Mar. 27 | Mar. 17 | Mar. 13 |
| Whippoorwill, *Antrostomus vociferus* | Apr. 27 | Apr. 22 | Apr. 30 | | | | | | | |
| Night Hawk, *Chordeiles virginianus* | Apr. 30 | Apr. 28 | May 6 | May 17 | May 10 | May 10 | May 7 | May 13 | May 17 | May 11 |
| Chimney Swift, *Chætura pelagica* | Apr. 17 | Apr. 12 | Apr. 23 | Apr. 22 | Apr. 20 | Apr. 25 | Apr. 21 | Apr. 18 | Apr. 26 | Apr. 22 |
| Hummingbird, *Trochilus colubris* | May 3 | Apr. 28 | May 10 | May 7 | | May 7 | May 7 | May 12 | May 12 | May 9 |
| Kingbird, *Tyrannus tyrannus* | Apr. 29 | Apr. 23 | May 2 | May 2 | May 9 | May 5 | May 4 | Apr. 30 | May 5 | May 4 |
| Crested Flycatcher, *Myiarchus crinitus* | Apr. 29 | Apr. 25 | May 2 | May 1 | May 6 | May 5 | May 3 | May 2 | May 8 | May 4 |
| Phœbe, *Sayornis phœbe* | Mar. 13 | Mar. 6 | Mar. 16 | Mar. 23 | Mar. 15 | Mar. 20 | Mar. 19 | Apr. 4 | Mar. 17 | Mar. 21 |
| Wood Pewee, *Contopus virens* | May 3 | Apr. 30 | May 6 | May 6 | May 12 | May 10 | May 8 | May 6 | May 14 | May 9 |
| Acadian Flycatcher, *Empidonax virescens* | May 5 | Apr. 29 | May 13 | | | | | | | |
| Least Flycatcher, *Empidonax minimus* | Apr. 28 | Apr. 25 | May 1 | May 1 | | May 5 | May 1 | May 4 | May 4 | May 2 |
| Bobolink, *Dolichonyx oryzivorus* | May 2 | Apr. 30 | May 6 | May 9 | May 9 | May 8 | May 9 | May 3 | May 11 | May 8 |

| | First Arrival. | | | Bulk Arrival. | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Average | Extremes 1902–07 | | 1902 | 1903 | 1904 | 1905 | 1906 | 1907 | Average |
| Cowbird, *Molothrus ater* | Mar. 15 | Mar. 1 | Mar. 28 | ..... | Mar. 23 | Mar. 26 | Mar. 23 | Mar. 29 | Mar. 22 | Mar. 25 |
| Red-winged Blackbird, *Agelaius phœniceus* | Mar. 3 | Feb. 23 | Mar. 9 | Mar. 7 | Mar. 5 | Mar. 15 | Mar. 16 | Mar. 4 | Mar. 15 | Mar. 10 |
| Meadow Lark, *Sturnella magna* | Feb. 6* | Feb. 4 | Feb. 12 | ..... | Mar. 3 | Mar. 9 | Mar. 16 | Feb. 25 | Mar. 16 | Mar. 8 |
| Orchard Oriole, *Icterus spurius* | May 1 | Apr. 30 | May 4 | May 4 | May 9 | May 5 | May 4 | May 4 | May 4 | May 5 |
| Baltimore Oriole, *Icterus galbula* | May 1 | Apr. 30 | May 2 | May 4 | May 7 | May 5 | May 3 | May 3 | May 10 | May 5 |
| Rusty Blackbird, *Euphagus carolinus* | Mar. 15 | Mar. 12 | Mar. 19 | | | | | | | |
| Purple Grackle, *Quiscalus quiscula* | Feb.22* | Feb. 13 | Mar. 3 | Feb. 28 | Mar. 1 | Mar. 8 | Mar. 8 | Feb. 22 | Mar. 9 | Mar. 3 |
| Vesper Sparrow, *Poœcetes gramineus* | Mar. 16 | Feb. 25 | Mar. 24 | Apr. 5 | Mar. 31 | Mar. 27 | Mar. 26 | Apr. 8 | Mar. 24 | Mar. 30 |
| Savanna Sparrow, *Passerculus s. savanna* | Mar. 16 | Mar. 3 | Mar. 22 | | | | | | | |
| Grasshopper Sparrow, *Coturniculus p. savannarum* | Apr. 21 | Apr. 12 | Apr. 23 | Apr. 26 | Apr. 26 | May 1 | Apr. 27 | Apr. 29 | Apr. 28 | Apr. 28 |
| Chipping Sparrow, *Spizella socialis* | Mar. 22 | Mar. 18 | Mar. 29 | Mar. 30 | Mar. 22 | Apr. 4 | Mar. 27 | Apr. 7 | Mar. 28 | Mar. 29 |
| Field Sparrow, *Spizella pusilla* | Mar. 4* | Feb. 20 | Mar. 16 | Mar. 25 | Mar. 14 | Mar. 25 | Mar. 19 | Mar. 11 | Mar. 22 | Mar. 19 |
| Swamp Sparrow, *Melospiza georgiana* | Mar. 29 | Mar. 16 | Apr. 24 | | | | | | | |
| Fox Sparrow, *Passerella iliaca* | Mar. 1 | Feb. 20 | Mar. 14 | Mar. 8 | Mar. 1 | Mar. 12 | Mar. 16 | Feb. 24 | Mar. 15 | Mar. 8 |
| Towhee, *Pipilo erythrophthalmus* | Mar. 21 | Mar. 6 | Apr. 3 | Apr. 20 | Apr. 17 | Apr. 19 | Apr. 19 | Apr. 19 | Apr. 20 | Apr. 19 |
| Rose-breasted Grosbeak, *Zamelodia ludoviciana* | Apr. 30 | Apr. 26 | May 2 | May 4 | ..... | May 6 | May 7 | May 4 | May 11 | May 6 |
| Indigo-bird, *Passerina cyanea* | May 1 | May 1 | May 2 | May 8 | May 4 | May 6 | May 7 | May 5 | May 10 | May 7 |
| Scarlet Tanager, *Piranga erythromelas* | Apr. 28 | Apr. 21 | May 2 | May 2 | May 6 | May 6 | May 5 | May 3 | May 10 | May 6 |
| Purple Martin, *Progne subis* | Mar. 29 | Mar. 16 | Apr. 9 | | | | | | | |
| Cliff Swallow, *Petrochelidon lunifrons* | Apr. 29 | Apr. 23 | May 5 | | | | | | | |
| Barn Swallow, *Hirundo erythrogastra* | Apr. 10 | Mar. 27 | Apr. 16 | Apr. 18 | Apr. 24 | Apr. 24 | Apr. 23 | Apr. 22 | Apr. 26 | Apr. 23 |
| Tree Swallow, *Iridoprocne bicolor* | Apr. 8 | Mar. 28 | Apr. 12 | Apr. 24 | Apr. 24 | Apr. 23 | Apr. 23 | Apr. 19 | Apr. 21 | Apr. 22 |
| Bank Swallow, *Riparia riparia* | Apr. 14 | Apr. 8 | Apr. 22 | ..... | Apr. 18 | Apr. 24 | Apr. 30 | Apr. 15 | Apr. 28 | Apr. 19 |
| Rough-winged Swallow, *Stelgidopteryx serrepennis* | Apr. 13 | Mar. 30 | Apr. 25 | ..... | ..... | Apr. 24 | Apr. 30 | Apr. 14 | Apr. 27 | Apr. 19 |
| Cedarbird, *Ampelis cedrorum* | Mar. 7 | Mar. 4 | Mar. 14 | | | | | | | |
| Red-eyed Vireo, *Vireo olivaceus* | Apr. 30 | Apr. 27 | May 4 | May 4 | May 9 | May 6 | May 4 | May 4 | May 11 | May 6 |

| | First Arrival. | | | Bulk Arrival. | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Average | Extremes 1902–07 | | 1902 | 1903 | 1904 | 1905 | 1906 | 1907 | Average |
| Warbling Vireo, *Vireo gilvus* | May 2 | Apr. 30 | May 6 | May 4 | May 6 | May 7 | May 7 | May 5 | May 9 | May 6 |
| Yellow-throated Vireo, *Vireo flavifrons* | Apr. 29 | Apr. 25 | May 1 | Apr. 30 | May 7 | May 1 | May 2 | May 2 | May 6 | May 3 |
| Solitary Vireo, *Vireo solitarius* | Apr. 24 | Apr. 14 | Apr. 28 | | | Apr. 24 | Apr. 30 | Apr. 29 | May 4 | Apr. 29 |
| White-eyed Vireo, *Vireo noveboracensis* | Apr. 27 | Apr. 25 | Apr. 28 | Apr. 27 | May 6 | May 7 | May 3 | May 4 | May 4 | May 3 |
| Black-and-White Warbler, *Mniotilta varia* | Apr. 18 | Apr. 13 | Apr. 22 | Apr. 27 | Apr. 26 | Apr. 25 | Apr. 27 | Apr. 27 | Apr. 27 | Apr. 26 |
| Worm-eating Warbler, *Helmitheros vermivorus* | Apr. 29 | Apr. 27 | May 3 | | | May 3 | May 6 | May 6 | May 11 | May 9 |
| Blue-winged Warbler, *Helminthophila pinus* | May 1 | Apr. 28 | May 4 | May 3 | May 9 | May 7 | May 3 | May 3 | May 11 | May 6 |
| Parula Warbler, *Compsothlypis americana* | Apr. 28 | Apr. 25 | May 1 | May 2 | May 6 | May 4 | May 3 | May 3 | May 8 | May 4 |
| Yellow Warbler, *Dendroica æstiva* | Apr. 24 | Apr. 16 | Apr. 28 | Apr. 27 | Apr. 30 | May 3 | Apr. 30 | Apr. 30 | Apr. 30 | Apr. 30 |
| Black-throated Blue Warbler, *Dendroica cærulescens* | Apr. 27 | Apr. 24 | May 1 | May 3 | May 3 | May 3 | May 6 | May 3 | May 5 | May 4 |
| Myrtle Warbler, *Dendroica coronata* | Mar. 29 | Mar. 13 | Apr. 10 | Apr. 24 | Apr. 22 | Apr. 23 | Apr. 23 | Apr. 27 | Apr. 26 | Apr. 24 |
| Magnolia Warbler, *Dendroica maculosa* | May 1 | Apr. 28 | May 2 | May 8 | May 7 | May 9 | May 7 | May 3 | May 11 | May 7 |
| Chestnut-sided Warbler, *Dendroica pensylvanica* | May 1 | Apr. 27 | May 5 | May 3 | May 5 | May 10 | May 7 | May 4 | May 10 | May 6 |
| Black-poll Warbler, *Dendroica striata* | May 6 | May 4 | May 10 | May 11 | May 14 | May 9 | May 8 | May 7 | May 17 | May 11 |
| Blackburnian Warbler, *Dendroica blackburniæ* | May 4 | May 1 | May 11 | May 10 | May 12 | May 10 | May 8 | May 10 | May 8 | May 10 |
| Black-throated Green Warbler, *Dendroica virens* | Apr. 28 | Apr. 26 | Apr. 30 | May 1 | May 1 | May 3 | May 6 | Apr. 30 | May 8 | May 3 |
| Pine Warbler, *Dendroica vigorsii* | Apr. 20 | Apr. 13 | Apr. 27 | | | | | | | |
| Yellow Palm Warbler, *Dendroica p. hypochrysea* | Apr. 10 | Mar. 25 | Apr. 23 | Apr. 25 | Apr. 19 | Apr. 15 | Apr. 13 | Apr. 13 | Apr. 18 | Apr. 17 |
| Prairie Warbler, *Dendroica discolor* | May 1 | Apr. 29 | May 8 | | | | | | | |
| Ovenbird, *Seiurus aurocapillus* | Apr. 26 | Apr. 22 | Apr. 28 | Apr. 28 | May 1 | May 1 | Apr. 30 | Apr. 30 | Apr. 30 | Apr. 30 |
| Water Thrush, *Seiurus noveboracensis* | Apr. 25 | Apr. 21 | Apr. 27 | May 4 | May 6 | Apr. 30 | May 3 | May 3 | May 5 | May 3 |
| Kentucky Warbler, *Oporornis formosa* | Apr. 30 | Apr. 27 | May 4 | May 4 | May 7 | May 7 | May 4 | May 3 | May 8 | May 6 |
| Maryland Yellow-throat, *Geothlypis trichas* | Apr. 21 | Apr. 15 | Apr. 26 | Apr. 27 | Apr. 30 | Apr. 26 | Apr. 28 | Apr. 29 | Apr. 28 | Apr. 28 |

| | First Arrival. | | | | Bulk Arrival. | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Average | Extremes 1902–07 | | | 1902 | 1903 | 1904 | 1905 | 1906 | 1907 | Average |
| Yellow-breasted Chat, *Icteria virens* | Apr. 29 | Apr. 22 | May | 3 | May 4 | May 6 | May 3 | May 6 | May 5 | May 10 | May 5 |
| Canada Warbler, *Wilsonia canadensis* | May 5 | May 2 | May | 9 | May 10 | May 18 | May 11 | May 7 | May 12 | May 12 | May 12 |
| Redstart, *Setophaga ruticilla* | Apr. 25 | Apr. 19 | Apr. | 29 | May 3 | May 6 | May 2 | Apr. 30 | May 1 | May 8 | May 3 |
| Catbird, *Galeoscoptes carolinensis* | Apr. 21 | Apr. 15 | Apr. | 24 | Apr. 26 | May 1 | Apr. 30 | Apr. 30 | Apr. 29 | May 1 | Apr. 29 |
| Brown Thrasher, *Toxostoma rufum* | Apr. 1 | Mar. 9 | Apr. | 22 | Apr. 24 | Apr. 24 | Apr. 25 | Apr. 22 | Apr. 21 | Apr. 27 | Apr. 24 |
| House Wren, *Troglodytes ædon* | Apr. 21 | Apr. 18 | Apr. | 25 | Apr. 30 | Apr. 25 | Apr. 26 | Apr. 25 | Apr. 25 | Apr. 29 | Apr. 27 |
| Long-billed Marsh Wren, *Telmatodytes palustris* | May 10 | Apr. 30 | May | 15 | | | | | | | |
| Ruby-crowned Kinglet, *Regulus calendula* | Apr. 2 | Mar. 28 | Apr. | 7 | | Apr. 16 | Apr. 11 | Apr. 11 | Apr. 14 | Apr. 21 | Apr. 12 |
| Wood Thrush, *Hylocichla mustelina* | Apr. 24 | Apr. 22 | Apr. | 26 | Apr. 28 | May 2 | Apr. 30 | Apr. 28 | Apr. 29 | May 1 | Apr. 30 |
| Wilson's Thrush, *Hylocichla fuscescens* | Apr. 26 | Apr. 24 | Apr. | 30 | May 2 | May 1 | May 1 | May 1 | May 3 | May 5 | May 2 |
| Gray-cheeked Thrush, *Hylocichla aliciæ* | May 3 | Apr. 27 | May | 8 | | | May 13 | May 9 | May 15 | May 12 | May 12 |
| Olive-backed Thrush, *Hylocichla ust. swainsoni* | Apr. 30 | Apr. 22 | May | 3 | | | May 5 | May 6 | May 6 | May 11 | May 7 |
| Hermit Thrush, *Hylocichla g. pallasi* | Apr. 1 | Mar. 14 | Apr. | 7 | Apr. 17 | Apr. 11 | Apr. 13 | Apr. 9 | Apr. 13 | Apr. 13 | Apr. 13 |
| Robin, *Merula migratoria* | Feb.11* | Feb. 11 | Feb. | 22 | Feb. 28 | Mar. 3 | Mar. 6 | Mar. 8 | Feb. 20 | Mar. 13 | Mar. 4 |
| Bluebird, *Sialia sialis* | Feb.17* | Feb. 11 | Feb. | 24 | | Mar. 2 | Mar. 4 | Mar. 6 | Feb. 22 | May 5 | Mar. 2 |